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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/684,950	10/13/2003	Michael A. Horton	18856-08206	3679

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EXAMINER	
WASHBURN, DOUGLAS N	

ART UNIT	PAPER NUMBER
2863	

DATE MAILED: 06/10/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/684,950	HORTON, MICHAEL A.
	Examiner	**Art Unit**
	Douglas N Washburn	2863

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *02 February 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-29* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3,6-8 and 10-29* is/are rejected.

7)☒ Claim(s) *4,5 and 9* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *02 February 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 2 FEBRUARY 2004

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Double Patenting

1 The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970);and, *In re Thorington,* 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

Claims 1-3, 6-8 and 10-17 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-3, 6-7 and 10-17 of U.S. Patent No. 6,421,622.

10/684,950	Prior Art to US 6,421,622

[redacted]

1. A method for determining an attitude of an accelerating object exclusively from acceleration and angular rate, comprising: determining an angular rate of the object for conversion into a direction cosine matrix; determining a level frame acceleration value of the object based upon the direction cosine matrix and an acceleration of the object; generating a corrective rate signal based upon the level frame acceleration value; and updating the direction cosine matrix based upon the determined angular rate of the object and the corrective rate signal to obtain the attitude of the object.	1. A method for determining an attitude of an accelerating object exclusively from acceleration and angular rate, comprising: determining an angular rate of the object to obtain a quarternion representation of attitude; converting the quarternion into a direction cosine matrix; determining a level frame acceleration value of the object based upon the direction cosine matrix and an acceleration of the object; generating a corrective rate signal based upon the level frame acceleration value; and updating the quarternion representation based upon the determined angular rate of the object and the corrective rate signal, and converting the updated quarternion into a direction cosine matrix to obtain the attitude of the object.
2. The method of claim 1 further comprising: extracting Euler Angles from the direction cosine matrix to represent the attitude of the object. 3. The method of claim 1 wherein the corrective signal includes a correction component to correct for a heading deviation of the object.	2. The method of claim 1 further comprising: extracting Euler Angles from the direction cosine matrix to represent the attitude of the object. 3. The method of claim 1 wherein the corrective signal includes a correction component to correct for a heading deviation of the object.
6. The method of claim 1 wherein the gain of the correction signal is adjustable. 7. The method of claim 1 wherein calibrated data is obtained by applying compensation parameters to the raw sensor data.	6. The method of claim 1 wherein the gain of the correction signal is adjustable. 7. The method of claim 1 wherein calibrated data is obtained by applying compensation parameters to the raw sensor data.

8. The method of claim 1 wherein an automated calibration procedure provides the compensation parameters used to compensate the raw sensor data.	8. The method of claim 1 wherein an automated calibration procedure provides the compensation parameters used to compensate the raw sensor data.
10. A self-contained system capable of determining an attitude of an accelerating object exclusively from acceleration and angular rate, the system, comprising: an acceleration sensor aligned with each of a plurality of orthogonally oriented axes of rotation of the object for providing an acceleration value; an angular rate sensor aligned with each of the plurality of orthogonally oriented axes of rotation of the object for providing an angular rate value; a processor for receiving the acceleration value from the acceleration sensor and the angular rate value from the angular rate sensor, and for executing a computer program that performs the steps of : <u>establishing a direction cosine matrix representation of attitude based upon the angular rate value;</u> determining a level frame acceleration value of the object based upon the direction cosine matrix and the acceleration of the object; generating a corrective rate signal based upon the level frame acceleration; and updating the direction cosine matrix representation based upon the angular rate of the object and the corrective rate signal to obtain the attitude of the object.	10. A self-contained system capable of determining an attitude of an accelerating object exclusively from acceleration and angular rate, the system, comprising: an acceleration sensor aligned with each of a plurality of orthogonally-oriented axes of rotation of the object for providing an acceleration value; an angular rate sensor aligned with each of the plurality of orthogonally-oriented axes of rotation of the object for providing an angular rate value; a processor for receiving the acceleration value from the acceleration sensor and the angular rate value from the angular rate sensor, and for executing a computer program that performs the steps of: establishing <u>a quarternion representation of attitude based on the angular rate value</u>; <u>converting the quartemion into a direction cosine matrix;</u> determining a level frame acceleration value of the object based upon the direction cosine matrix and the acceleration of the object; generating a corrective rate signal based upon the level frame acceleration; and updating the quarternion representation based upon the angular rate of the object and the corrective rate signal to obtain the attitude of the object.

11. The system of claim 10 further comprising: a temperature sensor, coupled to the processor, for providing temperature data to compensate the angular rate sensors and acceleration sensors which provide the update and correction to the update of the direction cosine matrix.	11. The system of claim 10 further comprising: a temperature sensor, coupled to the processor, for providing temperature data used to compensate the gyros and accelerometers which provide the update and correction to the update of the quarternion.
12. The system of claim 10 further comprising: a magnetic sensor, coupled to the processor, for providing heading data to update the direction cosine matrix. 13. The system of claim 10 further comprising: a frequency compensation stage for frequency compensating the angular rate sensors and acceleration sensors to provide enhanced dynamic response of, reduce the noise in, and reduce the sensitivity to vibration of the updated direction cosine matrix. 14. The method of claim 1 further comprising: using a local level-plane predefined maneuvering Kalman Filter algorithm to automatically estimate and provide gyro and accelerometer calibration coefficients.	12. The system of claim 10 further comprising: a magnetic sensor, coupled to the processor, for providing heading data used to update the quarternion. 13. The system of claim 10 further comprising: a frequency compensation stage for performing frequency compensation to the gyros and accelerometers which can provide enhanced dynamic response of, reduce the noise in, and reduce the sensitivity to vibration of the quarternion update. 14. The method of claim 1 further comprising: using a local level-plane predefined maneuvering Kalman Filter algorithm to automatically estimate and provide gyro and accelerometer calibration coefficients.
15. A self-contained system for determining an attitude of an accelerating object exclusively from acceleration and angular rate, the system comprising: a plurality of acceleration sensors configured to determine an acceleration rate of the accelerating object, each acceleration sensor being aligned with one of a plurality of orthogonally- oriented axes of rotation of the object; a plurality of angular rate sensors configured to determine the angular rate of the accelerating object, each angular	15. A self-contained system for determining an attitude of an accelerating object exclusively from acceleration and angular rate, the system comprising: a plurality of acceleration sensors configured to determine an acceleration rate of the accelerating object, each acceleration sensor being aligned with one of a plurality of orthogonally-oriented axes of rotation of the object; a plurality of angular rate sensors configured to determine the angular rate of the accelerating object, each angular

rate sensor being aligned with one of the plurality of orthogonally-oriented axes of rotation of the object;	rate sensor being aligned with one of the plurality of orthogonally-oriented axes of rotation of the object;
wherein an initial calibration is performed for the plurality of acceleration sensors and angular rate sensors disposed about the orthogonally-oriented axes of rotation for producing calibration data;	wherein an initial calibration is performed for the plurality of acceleration sensors and angular rate sensors disposed about the orthogonally-oriented axes of rotation for producing calibration data;
a processor coupled to the acceleration sensors and the angular rate sensors and including a memory for storing calibration data, the processor configured to determine the attitude of the accelerating object by:	a processor coupled to the acceleration sensors and the angular rate sensors and including a memory for storing calibration data, the processor configured to determine the attitude of the accelerating object by:
converting the acceleration rate and the angular rate in time-sequenced share mode;	converting in one processing cycle the acceleration rate and the angular rate in time-sequenced share mode;
using the stored calibration data to calibrate the acceleration rate and angular rate of the accelerating object based upon temperature and misalignment of the plurality of sensors on the object;	using the stored calibration data to calibrate the acceleration rate and angular rate of the accelerating object based upon temperature and misalignment of the plurality of sensors on the object;
computing a direction cosine matrix representation of attitude of the accelerating object based upon the angular rate and a corrective angular rate of the accelerating object;	computing a quaternion representation of attitude of the accelerating object based upon the angular rate and a corrective angular rate of the accelerating object, and normalizing the quarternion representation; converting the quarternion representation into a direction cosine matrix;
multiplying the direction cosine matrix with a compensated acceleration rate to obtain a true acceleration of the object without tilt;	multiplying the direction cosine matrix with a compensated acceleration rate to obtain a true acceleration of the object without tilt;
generating a corrective rate signal based upon the true acceleration of the object without tilt;	generating a corrective rate signal based upon the true acceleration of the object without tilt;
and extracting Euler angles from the direction cosine matrix for producing a representative output.	and extracting euler angles from the direction cosine matrix for producing a representative output.

16. The system of claim 15 further comprising:	16. The system of claim 15 further comprising:
a plurality of magnetic sensors coupled to the processor and configured to provide a correction rate for yaw axis acceleration.	a plurality of magnetic sensors coupled to the processor and configured to provide a correction rate for yaw axis acceleration.
17. A method of determining an attitude of an accelerating object exclusively from sensors of acceleration and angular rate, comprising:	17. A method of determining an attitude of an accelerating object exclusively from acceleration and angular rate, comprising:
performing an initial calibration of the plurality of sensors configured to sense the acceleration rate and the angular rate of an accelerating object;	performing an initial calibration of a plurality of sensors configured to sense the acceleration rate and the angular rate of an accelerating object;
sensing the acceleration rate and the angular rate of the accelerating object by use of the plurality of sensors;	sensing the acceleration rate and the angular rate of the accelerating object by use of the plurality of sensors;
converting the acceleration rate and the angular rate in time-sequenced share mode;	converting in one processing cycle the acceleration rate and the angular rate in time-sequenced share mode;
using stored calibration data to calibrate the acceleration rate and angular rate of the accelerating object based upon temperature and misalignment of the plurality of sensors on the object;	using stored calibration data to calibrate the acceleration rate and angular rate of the accelerating object based upon temperature and misalignment of the plurality of sensors on the object;
computing a direction cosine matrix representation of attitude of the accelerating object based upon the angular rate and a corrective angular rate of the accelerating object;	computing a quarternion representation of attitude of the accelerating object based upon the angular rate and a corrective angular rate of the accelerating object,
	and normalizing the quarternion representation;
	converting the quarternion representation into a direction cosine matrix;
multiplying the direction cosine matrix with a compensated acceleration rate to obtain a true acceleration of the object without tilt;	multiplying the direction cosine matrix with a compensated acceleration rate to obtain a true acceleration of the object without tilt;
generating a corrective rate signal based upon the true	generating a corrective rate signal based upon the true

acceleration of the object without tilt; and extracting Euler angles from the direction cosine matrix for producing a representative output.	acceleration of the object without tilt; and extracting euler angles from the direction cosine matrix for producing a representative output.

Although the conflicting claims are not identical, they are not patentably distinct from each other because the independent claims of the present application differ from the patented claims in having the phrase: "determining an angular rate of the object for conversion into a direction cosine matrix" or the equivalent language. In order to determine a level frame acceleration value of the object based upon the direction cosine matrix and an acceleration of the object, applicant must convert the quaternion in to a direction cosine matrix. Therefore, the subject claims are broader than the Patent claims. It would therefore have been obvious to modify the claims of U.S. Patent No. 6,421,622 to claim the more limited "determining an angular rate of the object to obtain a quaternion representation of attitude; converting the quaternion in to a direction cosine matrix; determining a level frame acceleration value of the object based upon the direction cosine matrix and an acceleration of the object".

Claims 18-29 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-12 of U.S. Patent No. 6,647,352.

18. A method for determining an attitude of an accelerating object exclusively from acceleration and angular rate, comprising: determining an angular rate of the object for conversion to a direction cosine matrix;	1. A method for determining an attitude of an accelerating object exclusively from acceleration and angular rate, comprising: determining an angular rate of the object to obtain a quaternion representation of attitude; converting the quaternion in to a direction cosine

	matrix;
determining a level frame acceleration value of the object based upon the direction cosine matrix and an acceleration of the object; and supplying attitude error and rate sensor bias estimates to a Kalman filter operating on the level frame acceleration value as a reference to determine the attitude of the object.	determining a level frame acceleration value of the object based upon the direction cosine matrix and an acceleration of the object; supplying attitude error and rate sensor bias estimates to a Kalman filter operating on the level frame acceleration value as a reference to determine the attitude of the object.
19. The method of claim 18 in which attitude error estimate includes determining: acceleration magnitude from acceleration information along multiple orientation axes excluding gravity orientation; and invalidating attitude determination in response to the acceleration magnitude exceeding a selected value as indicative of a dynamic maneuver. 20. The method according to claim 18 in which attitude determination is invalidated in response to yaw rate information exceeding a selected value as indicative of a turn maneuver.	2. The method of claim 1 in which attitude error estimate includes determining acceleration magnitude from acceleration information along multiple orientation axes excluding gravity orientation; and invalidating attitude determination in response to the acceleration magnitude exceeding a selected value as indicative of a dynamic maneuver. 3. The method according to claim 1 in which attitude determination is invalidated in response to yaw rate information exceeding a selected value as indicative of a turn maneuver.
21. The method according to claim 18 including also supplying heading information to the Kalman filter operating on the level frame acceleration value as a reference to determine the attitude of the object. 22. The method according to claim 21 in which heading information includes compass heading data.	4. The method according to claim 1 including also supplying heading information to the Kalman filter operating on the level frame acceleration value as a reference to determine the attitude of the object. 5. The method according to claim 4 in which heading information includes compass heading data.
23. The method according to claim 21 in which heading information includes magnetometer data.	6. The method according to claim 4 in which heading information includes magnetometer data.

24. The method according to claim 21 in which heading information includes GPS information.	7. The method according to claim 4 in which heading information includes GPS information.
25. The method according to claim 20 in which yaw rate information supplied to the Kalman filter prior to the indicated turn maneuver is supplied for the duration of the yaw rate information exceeding the selected value. 26. The method according to claim 25 in which the state model noise covariance of the Kalman filter is lowered during the acceleration magnitude 3 exceeding the selected value.	8. The method according to claim 3 in which yaw rate information supplied to the Kalman filter prior to the indicated turn maneuver is supplied for the duration of the yaw rate information exceeding the selected value. 9. The method according to claim 8 in which the state model noise covariance of the Kalman filter is lowered during the acceleration magnitude exceeding the selected value.
27. The method according to claim 25 in which the weighting of the accelerometer attitude reference is lowered in the Kalman filter during the yaw rate 3 information exceeding the selected value. 28. The method according to claim 18 in which the determination of angular rate of an object includes manipulating the object through a predefined set 3 of maneuvers including an initial position as the final position of the maneuvers, 4 and estimating calibration parameters therefrom. 29. The method according to claim 28 in which a Kalman filter calculates the calibration parameters from acceleration and angular rate data from the object 3 as manipulated through the set of maneuvers.	10. The method according to claim 8 in which the weighting of the accelerometer attitude reference is lowered in the Kalman filter during the yaw rate information exceeding the selected value. 11. The method according to claim 1 in which the determination of angular rate of an object includes manipulating the object through a predefined set of maneuvers including an initial position as the final position of the maneuvers, and estimating calibration parameters therefrom. 12. The method according to claim 11 in which a Kalman filter calculates the calibration parameters from acceleration and angular rate data from the object as manipulated through the set of maneuvers.

Although the conflicting claims are not identical, they are not patentably distinct from each other because the independent claims of the present application differ from the patented claims in having the phrase: “determining an angular rate of the object for conversion into a direction cosine matrix” or the equivalent language. In order to determine a level frame acceleration value of the object based upon the direction cosine

matrix and an acceleration of the object, applicant must convert the quaternion in to a direction cosine matrix. Therefore, the subject claims are broader than the Patent claims. It would therefore have been obvious to modify the claims of U.S. Patent No. 6,647,352 to claim the more limited "determining an angular rate of the object to obtain a quaternion representation of attitude; converting the quaternion in to a direction cosine matrix; determining a level frame acceleration value of the object based upon the direction cosine matrix and an acceleration of the object".

Allowable Subject Matter

2 Claims 4, 5 and 9 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

3 Any inquiry concerning this communication or earlier communications from the examiner should be directed to Douglas N Washburn whose telephone number is (571) 272-2284. The examiner can normally be reached on Monday through Thursday 6:30 AM - 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John E Barlow can be reached on (571) 272-2269. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR.

Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

DNW

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